

Claims

1. A force sensor (200) fabricated in a micro machined process, for use in for instance a nanoindentation setup, wherein said force sensor (200) comprise:
- 5 – a membrane (207) movable in relation to a bulk structure;
- at least one detection element (206) in a detection structure (206) in connection with a bulk structure (210);
- connectors (208) for connecting said force sensor to electronics;
- 10 characterized in that said membrane (207) is attached to said bulk structure (210) through at least one spring (201, 202, 203, 204) and that said membrane (207) include a probe holding structure (214), said at least one spring (201, 202, 203, 204) provide said membrane (207) with movement capabilities for said membrane (207) in at least one direction with respect to said bulk structure (210); said movement is measured using said at least
- 15 one detection element (206).
2. The force sensor (200) according to claim 1, wherein said detection structure (206) comprise at least three detection elements; providing both lateral and horizontal sensitivity.
- 20 3. The force sensor (200) according to claim 1, wherein a force acting on a probe (211) attached to said probe holding structure (214) is measured by detecting capacitive changes between said membrane (207) and said detection element (206).
- 25 4. The force sensor (200) according to claim 1, wherein a force acting on a probe (211) attached to said probe holding structure (214) is measured by detecting a piezoelectric effect in a detection element (201, 202, 203, 204).
- 30 5. The force sensor (200) according to claim 1, wherein said membrane (207) has a rectangular shape as seen from a view perpendicular to a plane parallel to said detection element (206).
- 35 6. The force sensor (200) according to claim 1, wherein said membrane (207) is attached to said bulk structure (210) with eight springs (201, 202, 203, 204).

7. The force sensor (200) according to claim 6, wherein said springs (201, 202, 203, 204) are located two on each side of said membrane (207) as seen from a view perpendicular to a plane parallel to said detection element (206); said two springs (201, 202, 203, 204) are located in a mirror like formation providing symmetric movement.
8. The force sensor (200) according to claim 1, wherein said at least one spring (800) comprise a U-shaped form with heels (801) protruding at two respective open ends in order to space said U-shaped form away from said membrane (805) and said bulk structure (804).
9. The force sensor (200) according to claim 1, wherein said probe holding structure (214) is formed with a recessed open end relative said bulk structure (210).
10. A nanoindentation system (300) for use in a transmission electron microscope (101), comprising
- a force sensor (200, 306) comprising:
 - a. a membrane (207) movable in relation to a bulk structure;
 - b. at least one detection element (206) in a detection structure (206) in connection with a bulk structure (210);
 - c. connectors (208) for connecting said force sensor to electronics; wherein said membrane (207) is attached to said bulk structure (210) through at least one spring (201, 202, 203, 204) and that said membrane (207) include a probe holding structure (214), said at least one spring (201, 202, 203, 204) provide said membrane (207) with movement capabilities for said membrane (207) in at least one direction with respect to said bulk structure (210); said movement is measured using said at least one detection element (206);
 - a nanoindentation probe (211, 305) mounted on said force sensor (200, 306);
 - a displacement device (302, 303); and
 - a sample holding structure (304);
- wherein said force sensor (200, 306), nanoindentation probe (211, 305), displacement device (302, 303), and sample holding structure (304) are mounted on a transmission electron microscopy (TEM) sample holder (104),

said sample holding structure (304) and nanoindentation probe (211, 305) are movable in relation to each other.

- 5 11. The nanoindentation system (300) according to claim 10, wherein said displacement device is an inertial motor;
12. A method for producing a force sensor (200), using a substrate with a buried oxide layer, comprising the basic steps of:
- 10 – etching a cavity on a first side of said substrate;
 - providing on said first side of said substrate with an oxide mask;
 - p++ doping on a second side of said substrate;
 - patterning said second side of said substrate using double-sided lithography and etching down said second side of said substrate to said buried oxide layer;
 - 15 – providing an enhanced oxide mask on said first side of said substrate and etching springs;
 - deep dry etching of said first side of said substrate to obtain a probe holding structure (214); and
 - 20 – bonding said sensor chip anodically with a glass substrate comprising connectors (208).
13. The method according to claim 12, wherein a plurality of said force sensor (200) are produced on wafer.
- 25 14. A nanoindentation sample (700) for use in a nanoindentation system (300), comprising
- a base plate (701) providing mounting areas (706); and
 - a ridge (703) located essentially centered and integrally formed on said base plate;
- 30 characterized in that said ridge (703) extends along said base plate (701) with a wide base at said base plate (701) and a sharp edge (702) protruding away from said base plate (701); a curve form of said ridge as seen from a side view has a more steep narrowing towards said edge (702) than linear.
- 35 15. The nanoindentation sample (700) according to claim 14, further comprising a hole or intrusion (705) on a back side of said sample (700) in order to facilitate mounting of said sample (700) on a sample holder (309).